SCAFFOLDING MEMBER AND PRODUCTION METHOD

Field of the Invention

The present invention relates to methods for producing structural scaffolding members. In particular, although not exclusively, the invention relates to structural scaffolding members made from reinforced plastics material by a process of filament winding. However, the invention also relates to methods of forming structural members which may have other uses beyond scaffolding structures. For example the structural members may have application in the building of temporary bridges or buildings. Scaffolding members and structural members are also within the scope of the present invention.

Background to the Invention

In western countries the use of timber in scaffolding structures was prevalent in the early part of the twentieth century. Due to the high number of industrial accidents and fire hazards arising from timber scaffolding, timber scaffolding has generally been replaced worldwide by steel tubular scaffolding.

However, in Asia, bamboo has been traditionally used for scaffolding. Bamboo scaffolding is still in use in China and Hong Kong. As a scaffolding material, bamboo has a number of advantages. Bamboo is economical and can be simply constructed without special tools. Bamboo scaffolding can also be constructed within a short period of time in a limited working space. The most significant advantage of bamboo scaffolding is its very strong bending strength and elasticity when freshly cut. However, the strength of bamboo decreases as time goes by because it gradually dehydrates over time. When the water content has reduced below 10% the bamboo becomes dry and cracks will appear. The maximum lifespan of bamboo scaffolding members is thus relatively short, only about 12 to 18 months. Thus bamboo is considered somewhat unreliable.

Additionally, the types of bamboo typically employed in scaffolding have a surface roughness which assists workers climbing on the scaffolding structure.

An additional advantage of bamboo scaffolding is the presence of nodes at regular intervals along the length of each piece of bamboo. These natural protuberances enhance the structural integrity of scaffolding constructed from bamboo. At the junction between

upright and horizontal pieces of bamboo, the nodes help to prevent the horizontal members from slipping down the vertical members. Nevertheless, the use of bamboo in scaffolding structures is still considered a safety risk due to various factors.

In view of the limitations of bamboo, it is gradually being superseded in Hong Kong by steel scaffolding members. Steel scaffolding members still possess disadvantages none the least of which is cost. The weight of steel scaffolding structures may also be problematic in some situations. Because of the cost and strength characteristics of steel, the distances between the structural members is generally very wide to reduce material by taking advantage of steel strength. These distances are often inconvenient for workers climbing on the scaffolding.

It would therefore be advantageous if the scaffolding or structural members could be produced which possess the reliability of steel scaffolding members with the advantages of surface roughness and/or spaced nodes possessed by bamboo.

It is therefore an object of the present invention to provide methods of producing structural or scaffolding members which overcome or at least substantially ameliorate some of the above mentioned disadvantages. An alternative object is to provide the public with a useful choice.

Summary of Invention

In accordance with a first aspect of the present invention there is provided a method of producing a structural scaffolding member including forming the scaffolding member of reinforced plastics material with appropriate levels of strength and stiffness and providing a gripping surface on the external periphery thereof.

The scaffolding member may be formed by any of the known methods for producing reinforced plastics. For example, the process of pultrusion may be incorporated into the method. This process is one whereby the reinforcements eg fibre bundles or tapes are drawn through a liquid thermoset resin bath and simultaneously formed and cured in a heated die from which the cured profile is then withdrawn. This process is not limited to unidirectional reinforcements and indeed the reinforcements can be bought into the profile in any desired orientation.

In a preferred form of the invention, the scaffolding member is produced by a process

known as filament winding. In this process, the reinforcing fibres are drawn through a liquid resin bath and applied to a rotating mould surface or mandrel. The scaffolding members in the present invention are preferably elongate tubes of substantially uniform section and thus the method of filament winding is particularly adapted for use in the present invention. However, the invention is not limited to the production of tubes and it may be economic to produce scaffolding members in the form of solid rods. Furthermore, the tubes or rods may be of any section such as circular, square or rectangular and need not be substantially uniform. For example, the cross-sectional thickness may increase along the length of the scaffolding members to enable the members to be used in upright orientation with the thicker ends at the base to provide additional strength.

The method of the invention is also not restricted to making the whole scaffolding member of reinforced plastics material. For instance, the reinforced plastics material may be wound around a substrate of another material eg non-reinforced plastics material or any other material to which the reinforced plastics material can be bonded.

The scaffolding members produced by the present invention may also be made up of a number of layers. It is not intended that the present invention be restricted to using the same process for each of the layers. For example, an inner substrate layer may be made by a process of pultrusion whereas an outer layer may be formed by filament winding over the pultruded layer. In a most preferred form of the invention, the scaffolding member is formed with four layers of reinforced plastics material each formed by a process of filament winding, with the initial layer wound around a mandrel.

The reinforcements used in the present invention which may be wound, pultruded or otherwise incorporated into the reinforced plastics material may come in any of various forms. The reinforcements may be in strands or bundles commonly referred to as rovings having approximately 60 single glass strands in a bundle treated with a coupling agent to promote adhesion of the glass to the plastic material). Bundles are otherwise referred to as "tows" when graphite or boron reinforcements are incorporated. Single strands, bundles, rovings or tows are particularly adapted for the process of filament winding. However, tapes may also be adapted for filament winding and/or pultrusion and these may be in either woven or unwoven form. The form of tapes is unlimited and even cylindrical mats may be incorporated into a pultrusion process.

Use of glass, graphite and boron fibres have already been mentioned. Aramid fibres may

also be used.

The windings may be conducted at any appropriate angle. As mentioned, it is preferred that the scaffolding member is made up of four layers of reinforced plastics material to provide the appropriate characteristics of strength and stiffness. The first layer (starting from the inside) is preferably formed by filament winding at an angle in the range of 10° and 20° to the longitudinal axis of the scaffolding member. The second layer is preferably wound at an angle in the range of 60° and 65° to the longitudinal axis. The third layer may then be formed by filament windings at an angle in the range of 10° to 20° to the longitudinal axis. The fourth layer may be wound at an angle in the range of 60° to 65° to the longitudinal axis.

The windings may be performed by wet wrapping which is the process described previously whereby the reinforcements are drawn through the resin bath immediately prior to being wound. Alternatively, a process of "prepregs" may also be adopted. This means that the reinforcements are pre-impregnated with thermosetting resin advanced in cure only through the B-stage.

The gripping surface may be formed on the external periphery of the scaffolding member by an applied medium. Preferably, the applied medium is granular material such as grit or sand which forms a coarse layer on the scaffolding member. However, other materials may be achieved to create the gripping surface. For example, a rough surface may be applied by chemical etching. Moreover, the invention is not limited to the use of applied mediums to create the gripping surface and mechanical processes such as scoring or knurling may be used to form the gripping surface.

The applied medium such as grit or sand may be applied to the external periphery of the scaffolding member while the resin is still wet. This may be achieved by spraying the granular material with the medium or passing the scaffolding member as formed through a sand pit. Alternatively, the granular material or other applied medium may be affixed by an adhesive. Alternatively, the gripping surface may be formed by the action of sand which is blasted onto the dry external periphery of the scaffolding member. A combination process may also be adapted by the action of sand, some of which adheres to the wet reinforced plastics material and some of which exerts an abrading effect on the external periphery of the reinforced plastics material. In the application of the applied medium, additional reinforcement pieces may be added to enhance the strength of the scaffolding member.

The applied medium is not restricted to being applied to the external periphery of the scaffolding member. As previously mentioned, the scaffolding member may be made up of a number of layers and the medium may be applied and subsequently covered by another layer of reinforced plastics material with a further layer of the medium being applied as an outer layer. Consider the example of four layers formed by a process of filament winding, the medium may be applied to the third layer of filament winding either before or after winding. Another layer of filament winding is then applied over the top with a final layer of the medium being applied on the external periphery. Multiple layers of the applied medium such as sand means that the gripping surface will be durable and not immediately wear away.

Preferably, the gripping surface extends about the entire periphery of the scaffolding member. Other arrangements are envisaged. For example, the gripping surface may be disposed at regular intervals such as in spaced bands.

An additional feature of the invention is the inclusion of one or more nodes extending from the external periphery of the scaffolding member as will be further explained subsequently.

In accordance with a second aspect of the present invention there is provided a structural scaffolding member formed of reinforced plastics material wherein the scaffolding member has a gripping surface formed on the external periphery.

In accordance with a third aspect of the present invention there is provided a method of producing a structural member including providing a substrate layer of the member having one or more pultrusions and applying an outer layer to the substrate layer such that the outer layer is integrally adhered to the substrate layer and the member is formed with one or more nodes at the external periphery by the presence of the one or more pultrusions.

Preferably, the structural member is produced from reinforced plastics material in which case any of the features described above in connection with the first aspect of the invention may have application here.

In a preferred form of the invention, the pultrusions may be created by one or more formers placed on the substrate layer. For example, the substrate layer may comprise a layer produced by pultrusion or filament winding about a mandrel. Moreover, the substrate layer may itself comprise a number of layers. In a most preferred form of the

invention, whereby the structural member is made up of four layers of filament wound reinforced plastics material, the formers are placed on the first (inner) wound layer.

The formers may comprise any shaped surface. Preferably the formers comprise rings extend about the circumference of the substrate layer. These rings may be split to facilitate their assembly with the substrate layer. These rings need not be continuous and a C-shaped member may suffice to create the desired pultrusion.

Once each former is in place, the outer layer may be produced by a process of filament winding over the top of each former.

In a preferred form of the invention the structural member is elongate and a plurality of spaced nodes are formed on the member.

In accordance with a fourth aspect of the present invention there is provided a structural member including a substrate layer having one or more protrusions with an outer layer integrally adhered to the substrate layer such that the member is formed with one or more nodes at the external periphery by the presence of the one or more protrusions.

In accordance with a fifth aspect of the present invention there is provided a method of producing a structural member including forming the member from reinforced plastics material which is wound to define one or more nodes at the external periphery thereof.

Thus, the nodes are not limited to being created by formers placed on a substrate layer. For example, the fifth aspect of the present invention includes within its scope, nodes being formed by the provision of a shaped mandrel such that when the reinforced plastics material is wound about the mandrel the nodes are automatically created. Furthermore, the nodes may be created by a buildup of the wound reinforcements. For example, in a normal helical winding pattern, there may be a deviation from the normal pattern at a predetermined location to wind circularly to build up material at that location, thereby creating a node. Non-geodesic winding patterns may also be adopted to create the nodes.

In accordance with a sixth aspect of the present invention there is provided a structural member formed of reinforced plastics material wherein the reinforcement is wound to define one or more nodes at the external periphery thereof.

The structural member defined above and in connection with the third aspect of the invention may have particular application as scaffolding members. However these aspects of the invention are not restricted in this regard and may be useful as structural members for other applications including temporary or semi-permanent bridge structures, viewing platforms, temporary shelters, etc.

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

The invention consists in the foregoing and also envisages constructions of which the following gives examples only.

Brief Summary of the Drawings

In order that the invention may be more fully understood, one embodiment will now be described by way of example with reference to the drawings in which:

Figure 1 is a perspective view of a conventional form of scaffolding;

Figure 2 is a schematic cross-sectional view of a scaffolding member constructed in accordance with a preferred embodiment of the present invention;

Figure 3 is a schematic side view of the scaffolding member shown in Figure 2; and

Figure 4 is a schematic part-sectional view of a typical scaffolding junction incorporating the scaffolding member shown in Figure 2.

Preferred Embodiment of the Invention

Figure 1 illustrates a typical scaffolding assembly 10 comprising a matrix of upright scaffolding members 12 and transverse members 14. The scaffolding members 12 and 14 are joined at the intersections by couplings 16. In the preferred embodiment in the invention as will be illustrated in connection with Figures 2 to 4, the upright scaffolding members incorporate spaced nodes to mitigate the likelihood of the couplings 16 sliding down the upright scaffolding members and hence maintain the transverse members 14 in position. It will be understood that this feature improves the structural integrity of the scaffolding structure.

As shown in the schematic cross-sectional illustration of Figure 2, the preferred embodiment of the scaffolding member 20 includes a first layer 22 of reinforced plastics material. This first layer 22 is formed by a process of filament winding by winding the resin impregnated reinforcements such as strands or bundles around a central mandrel (not shown). The first layer is wound at an angle in the range of 10° and 20° from the longitudinal axis.

The first layer 22 thus forms a substrate. When this substrate is dry or at least partially dry, a number of formers are placed around the substrate or first layer 22 at regular intervals along the length of the substrate 22.

A second layer 26 of reinforced plastics material is then formed about the combined substrate layer 22 and rings 24 by a process of filament winding. The angle of the windings is in the range of 60° to 65° from the longitudinal axis of the member 20. When this second layer 26 is dry or at least partially dry, a third layer 28 of reinforced plastics material is then formed about the second layer 26. This layer 28 is again formed by a process of filament winding with the windings conducted in the range of 10° and 20° from the longitudinal axis of the member 20.

As the resin in the third layer 28 is curing, sand is applied to coat the third layer 28, thus building up a layer of sand 30. A fourth layer 32 of reinforced plastics material is then provided by a process of filament winding at an angle in the range of 60° to 65° from the longitudinal axis of the member 20. Again, another layer 34 of sand is sprayed onto the fourth layer 32 while the resin in the fourth layer is curing. The sand provides a gripping surface at the external periphery of the scaffolding member 20, enabling workers to more safely climb the scaffolding structure. Multiple layers 30, 34 of sand are provided so that even if the outer layer 34 is worn, the other layer 30 will still provide the gripping surface.

Figure 3 is a side view of the scaffolding member 20 having a length dimension A of approximately 6 metres. The rings 24 are placed onto the substrate layer 22 spaced apart a distance B of approximately 750 mm so it can be seen from Figure 3 that the distance B between adjacent nodes 40 is approximately 750 mm apart. The transverse scaffolding members are secured by the couplers 16 to the upright scaffolding members. The spacing between adjacent transverse scaffolding members which is determined by the node spacing is thus a comfortable distance for workers to climb the scaffolding structure. The dimension C, the diameter of the scaffolding member 20, may be anywhere between approximately 38 and 46 mm the dimension D, the outer circumference of the nodes 40,

may be anywhere between approximately 40 and 48 mm.

Preferably, the relationship between the normal circumference of the scaffolding member 20 and the external circumference of the nodes 40 is such that a coupling in an untightened configuration can easily pass over the nodes 40 but can be tightened and reduced in diameter for securement to the scaffolding member 20 so that it is no longer able to pass over the nodes 40.

Figure 4 illustrates a typical junction between an upright scaffolding member 20 constructed in accordance with the present invention and a transverse structural member 14. The structural member 14 preferably has a gripping surface provided on the external periphery. The nodes 40 may be omitted in the transverse members.

A portion of the coupling can be seen in Figure 4. The coupling 16 includes a sleeve surrounding the external periphery of the upright scaffolding member 20. It can be seen that downward slippage of the sleeve is prevented by the presence of the node 40. The couplings 16 will thus operate effectively even if the coupling is not completely tight about the scaffolding member 20 resulting in a more structurally sound and safer scaffolding structure. Furthermore, since the need for tightly securing the couplings 16 is overcome, the strain and wear on the couplings 16 will be reduced and their life span will be increased.

The above describes only one embodiment of the present invention and modifications can be made thereto without departing from the scope of the present invention as defined in the claims.